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FINAL REPORT SKYHOOK BALLOON RESEARCH

CONTRACT NUMBER Nonr 4395(00)

TASK NR NUMBER NR 211-085/11-15-63

PRINCIPAL
INVESTIGATOR Dale W. Cox

PERIOD OF PERFORMANCE
COVERED Feb. 24, '64 thru Aug. 31, '64

CONTRACT WITH Office of Naval Research
Department of the Navy
Washington 25, D. C.



Contract No. Nonr 4395(00)

A. INTRODUCTION

In accordance with Contract Nonr 4395(00), Section D, flight profiles, flight trajectories, launch and flight descriptions and post flight analyses of problems or failures are hereby provided for the balloon launches covered by this contract.

B. TECHNICAL DATA

Three launches were made under this contract at the Pacific Missile Range, Point Mugu, California.

(1) Tethered Launch -- 0900, February 27, 1964

(2) MER P I Flight -- 0918, April 21, 1964

(3) MER P II Flight -- 0942, July 9, 1964

I. TETHERED LAUNCH

The objective of the tethered launch was to test the Sea-Space dynamic launch system and the payload pickup capability of a dummy MER P balloon. A full scale, identical weight, dummy balloon was used. After minor difficulty in tripping the release, the heavy gauge exterior launcher envelope opened at the top and the balloon was released. The balloon accelerated, first picking up its own weight, then lofting two 25 lb weights in train from the ground. At about 50 ft, the rope sling on

the second 25 lb weight opened, dropping the second weight back to the ground. The balloon and the first 25 lb payload were arrested by a tether line at approximately 300 ft.

Analysis

Postflight analysis suggested an improvement to the launch envelope release mechanism so that it would be omnidirectional and could be tripped from any direction relative to the latch. This was done and used on both MER P flights.

The objective of scaling the SSS launch technique, which had previously been successfully demonstrated on lighter payloads, to 25 lb payloads, was achieved.

II. MER P 1 FLIGHT

The balloon was inflated in a NMC hangar with normal inflation procedures. When the 34 lb UC/LRL payload of Dr. Kinsey Anderson was stated to be ready, the balloon was moved upwind approximately 200 ft on the cement apron for launch. During the period when the balloon was being moved, the cut-down squibs were connected to the payload by LRL personnel. One squib fired immediately, requiring a launch delay to recycle the payload*. As the balloon was being moved, the recovery helicopter circled the launch area photographing the balloon. When the balloon

*Subsequent investigation at LRL disclosed that if the battery hookup current surge and transmitter output were simultaneous, a squib might fire.

was located for launch, the helicopter banked away from the balloon, thereby directing its downwash at the balloon. The helicopter is estimated to have been 150 - 200 ft from the balloon. The resultant gust loading on the launcher envelope ripped the bottom of the launcher, allowing the balloon to escape out the bottom. The entire balloon thus came out the bottom of the launcher, apparently undamaged. The four (4) persons escorting the launcher held on to the payload line and tethered the balloon, hoping the payload would be ready and the launch could continue. However, a delay in cycling the payload allowed the wind to catch the tethered balloon, creating a sail, driving part of the balloon onto the cement apron. Several minutes later, with five (5) men straining to hold the balloon, the payload attachment fitting at the bottom sheared, releasing the balloon without a payload. The balloon ascended at approximately 1000 fpm in free flight for sixty-four minutes to 45,000 ft; then descended rapidly, approximately 3000 fpm, impacting near the Franklin Canyon Reservoir in the Santa Monica Mountains. The balloon was recovered. Flight Profiles and Flight Trajectories for this flight are attached.

Analysis

The MER P balloon is unstable without a payload greater than 13 lbs. Consequently, the balloon reached approximately forty-five thousand feet altitude, where, it is reasonable to assume, it turned over, dumping its helium. It then descended abruptly.

Postflight analysis showed the heavy PE launcher film had ripped circumferentially at its base, the rip initiating at an upwind point. The payload attachment line sheared through the heavy, reinforced bottom fitting of the balloon, when wind forces, estimated to be at least 500 lbs, acted on the balloon.

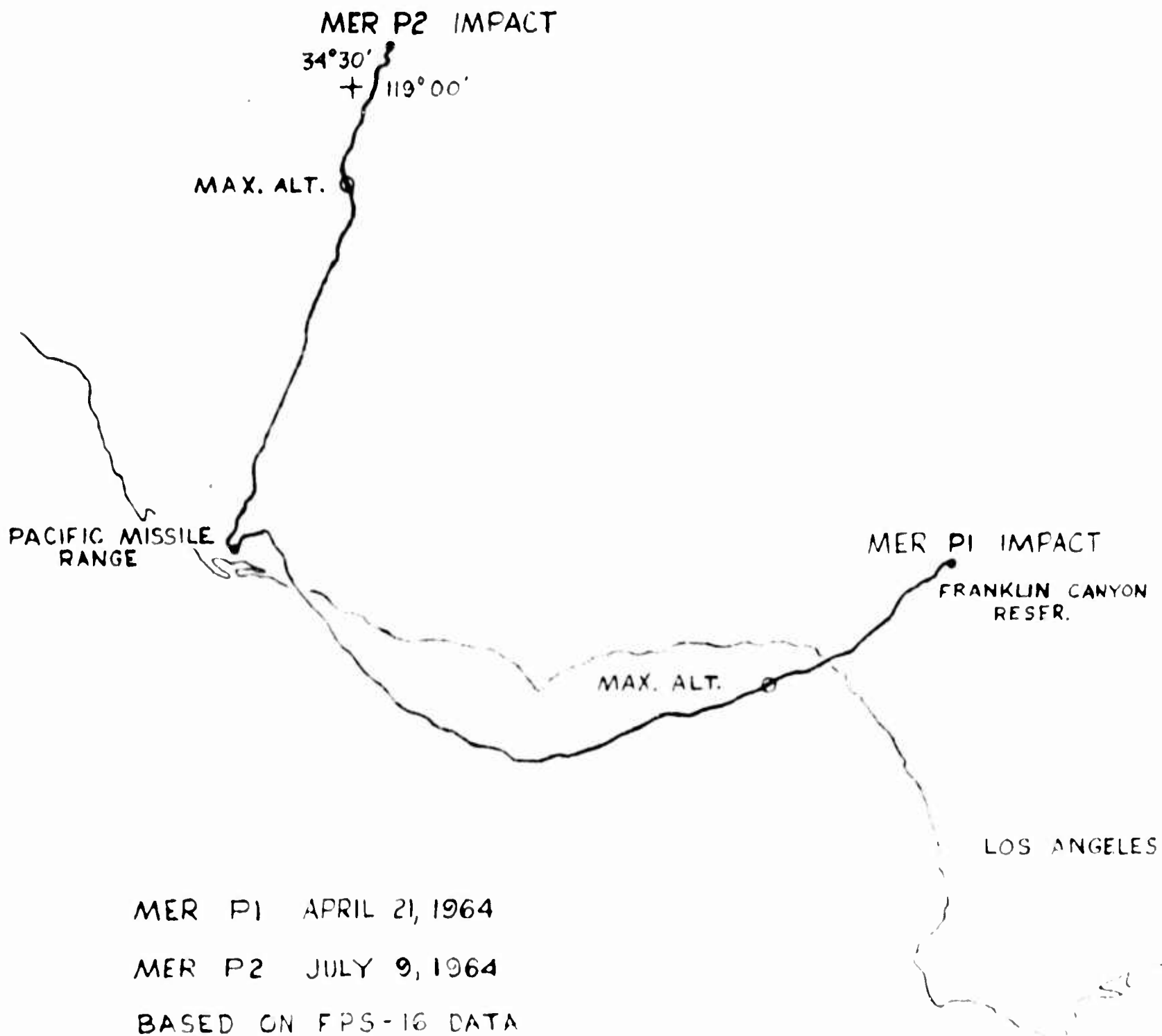
III. MER P II FLIGHT

Balloon inflation in a NMC hangar was normal. The balloon was moved out in a protected air space on the concrete apron adjacent to the hangar. Two men carried the payloads, one a radiosonde plus hypsometer, the other approximately twenty-two (22) pounds of sand ballast including SSS timer package. Total payload weight was 25 pounds. Field wind velocity at the time was 10 knots, although at the launcher it was calm, protected by the hangar. Balloon release from the launcher was normal. As the balloon bubble ascended above the protection of the hangar, it was apparently caught in a gust and moved laterally, pulling the balloon skirt out of the launcher at an increasing angle from the vertical, resulting in a slow emergence of the balloon out of the launcher. This, combined with the wind carrying the bubble down wind, caused the very bottom part of the balloon to emerge at a very low angle to the horizontal. However, the balloon was successfully airborne when the payload line fouled the launcher, pulling the payload held by two men abruptly in toward the

launcher. This resulted in the balloon becoming momentarily tethered, driving it toward the ground. In 5 to 8 seconds, the payload line was cleared but the freed balloon now jerked both payloads out of the hands of the men, dragging the payloads over the ground. The sand ballast was ripped open, spilling the sand and the radiosonde was knocked off. The undamaged balloon ascended with its reduced payload without further incident. The balloon reached 62,000 ft in 57.5 minutes. It then turned over, spilled its helium and descended at approximately 3000 fpm. A helicopter was dispatched and visually identified the balloon near a Forest Ranger's Station, 14 miles north of NMC, Point Mugu. (See attached Flight Profile and Flight Trajectory).

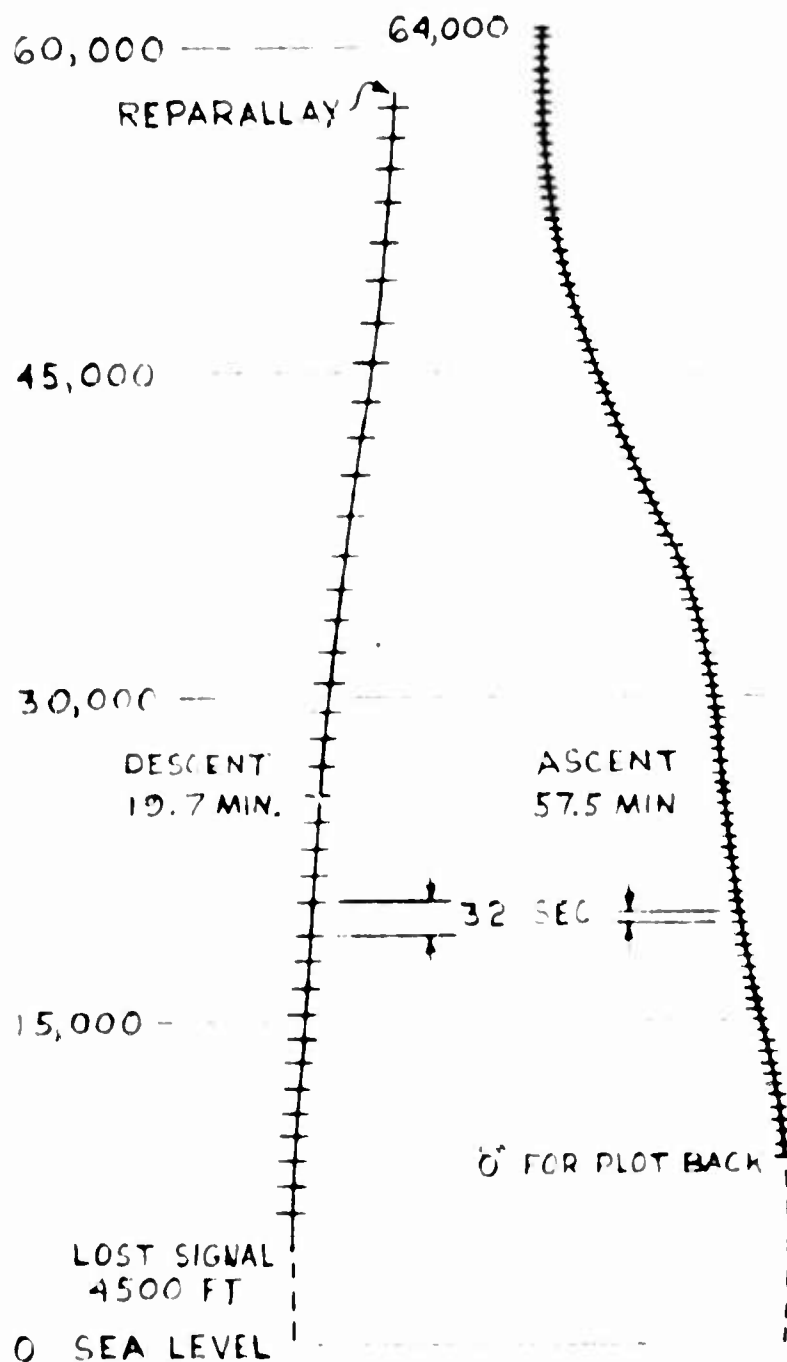
Analysis

Postflight investigation showed slight damage to the launcher from the payload line. It is believed the line hung up in a "bight" of plastic film, the first such occurrence of this kind in 18 launches with this type launcher. As shown by the MER P I flight, the MER P balloon is unstable without an adequate payload, and can turn over when it becomes inflated sufficiently.



MER P1 AND MER P2 FLIGHT PROFILES

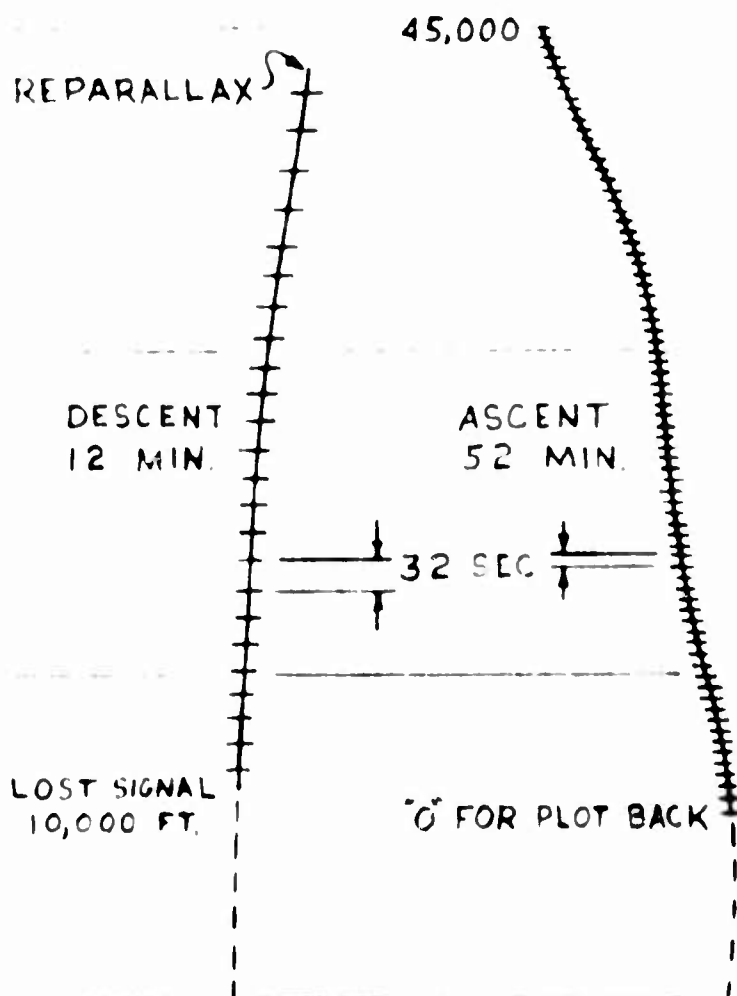
ALTITUDE
IN FEET



MER P2

JULY 9, 1964

ALTITUDE
IN FEET



MER P1

APRIL 21, 1964

BASED ON FPS-16 DATA

MER P1 AND MER P2 FLIGHT TRAJECTORIES